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happy years. I anticipate great additional interest to the walks, or rides, or drives which I may happen to take, by having it in my power to learn more of those objects of antique association, or of historic record, by which the capital and its delightful environs are so copiously studded. I only feel warranted in saying, further, that the pleasure with which I find myself amongst the members of this dignified Society is greatly enhanced on this occasion by our being met under the presidency of the Very Rev. Dean, in whom, besides his special adaptation for the immediate studies and pursuits which belong to this Institution, I have found, by competent experience, as complete a proficiency in all the branches of polished learning, in all the amenities of social intercourse, in true kindness and liberality of judgment, and in the benevolence and consistency of the whole Christian character. I beg to conclude by moving that the Addresses to which we have listened to-night may be printed.

The Rev. SAMUEL HAUGHTON, M. A., F. R. S., Fellow of Trinity College, Dublin, read the following paper:—

ACCOUNT OF EXPERIMENTS TO DETERMINE THE VELOCITIES OF RIFLE BULLETS COMMONLY USED.

THE following experiments were made for the purpose of ascertaining the reason of the alleged inferiority of the belted spherical bullet, used with the two-grooved rifle, as compared with elongated bullets of different kinds. The guns compared are the following:—

1. A two-grooved rifle,—length, 31·50 inches; diameter, 0·66 inch; one turn in 4 feet.
2. The regulation Minié rifle,—length, 39 inches; diameter, 0·69 inch.
3. Police carbine,—length, 28·75 inches; diameter, 0·66 inch.

With these guns were used the following bullets:—

Two-grooved Rifle.—1. A Minié bullet, provided with two projections corresponding to the grooves of the rifle, without 'culots,' weight 697 grs.; 2. A sugarloaf bullet, fired point foremost, weight 669·75 grs.; 3. A belted spherical bullet, weight 482 grs.

Minié Rifle.—The Regulation Minié bullet, with 'culot,' weight 744 grs.

Carbine.—Spherical bullet, weight 391 grs.

The method employed to determine the velocity of the bullets was Robins' ballistic pendulum; and the same quantity of the best gunpowder (40 grs.) was employed with each gun and bullet.

For the erection of the pendulum, and most efficient assistance afforded in the conduct of the experiments, I am indebted to Mr. Joseph Harris, of the firm of Trulock and Son, Dawson-street, Dublin, without whose aid I should have been unable to bring these experiments to a successful issue.

I shall first give the details of the experiments, and then mention the principal deductions which may be obtained from them.

The formula used in calculating the velocity is the following :*—

$$v = \frac{gTa}{\pi fc} \times nb, \qquad (1)$$

where v = velocity of bullet in feet per second.
T = time of oscillation of pendulum.
a = distance of centre of gravity from axis of suspension.
π = ratio of circumference of a circle to its diameter.
f = distance from axis of gun attached to pendulum to axis of suspension.
c = distance from axis of suspension to point of attachment of tape, by which the recoil is measured.
n = ratio of weight of pendulum to weight of bullet.
b = chord of arc of recoil, measured by tape.

The two-grooved rifle barrel being firmly strapped with iron plates to the pendulum, the constants of the pendulum were carefully determined, and were as follows :—

g = 32·195 ft. π = 3·14159 Weight of pend. = 36·75 lbs.
T = 1·29 sec. f = 75·25 in.
a = 57·39 in. c = 78·25 in.

From these data we obtain (1)

$$v = 0{\cdot}12894 \times nb. \qquad (2)$$

The following Tables contain the results of the experiments made on the recoil of the two-grooved rifle with the three bullets already described:—

TABLE I.—*Minié Bullet.*

No.	*n.*	*b.*	*v.*
		In.	Ft.
1.	369	17·50	833
2.	. .	18·25	869
3.	. .	17·25	821
4.	. .	18·50	881
5.	. .	18·00	857
6.	. .	17·25	821

Mean velocity = 847 feet per second.

Mean quantity of motion, measured in avoirdupois pounds, moving through 1 foot per second = 84·33 lbs.

Mean quantity of Work = 1109 lbs. lifted one foot.

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* Poisson, "Traité de Méchanique," vol. ii., p. 119.

TABLE II.—*Sugarloaf Bullet.*

No.	*n.*	*b.*	*v.*
		In.	Ft.
1.	384	17·50	866·2
2.	. .	17·00	841·5
3.	. .	17·37	859·8
4.	. .	17·75	878·6
5.	. .	17·62	872·3

Mean velocity = 863·7 feet.
Mean quantity of motion = 82·63 lbs.
Mean quantity of Work = 1108 lbs. lifted one foot.

TABLE III.—*Belted Bullet.*

No.	*n.*	*b.*	*v.*
		In.	Ft.
1.	533	14·75	1013·3
2.	. .	15·37	1055·9
3.	. .	14·75	1013·3
4.	. .	15·12	1038·7
5.	. .	14·37	987·2

Mean velocity = 1021·68.
Mean quantity of motion = 70·39 lbs.
Mean quantity of Work = 1116 lbs. lifted one foot.

The Minié regulation-rifle barrel having been attached to the pendulum, formula (1) was calculated with the following constants, and the results are given in Table IV.

The carbine barrel was then attached to the pendulum, and the recoil observed. The results are contained in Table V.

g = 32·195 feet. Weight of pend. and Minié barrel = 56·50 lbs.
T = 1·29 sec. Weight of pend. and carbine barrel = 55·25 lbs.
a = 61·75 in.
π = 3·14159.
f = 74 in.
c = 77 in.

From these constants we find

$$v = 0{\cdot}14326 \times nb. \tag{3}$$

TABLE IV.—*Minié Regulation Rifle.*

No.	*n.*	*b.*	*v.*
		In.	Ft.
1.	531	12·25	931·90
2.	. .	11·50	874·85
3.	. .	12·12	922·39
4.	. .	12·12	922·39
5.	. .	11·75	893·86

Mean velocity = 909·08 feet.
Mean quantity of motion = 96·63 lbs.
Mean quantity of Work = 1364 lbs. lifted one foot.

TABLE V.—*Carbine.*

No.	*n.*	*b.*	*v.*
		In.	Ft.
1.	989	9·00	1275·21
2.	. .	9·12	1292·92
3.	. .	8·75	1239·78
4.	. .	8·62	1222·07

Mean velocity = 1257·49 feet.
Mean quantity of motion = 70·24 lbs.
Mean quantity of Work = 1371 lbs. lifted one foot.

If we assume that the force developed by the explosion of the powder, diminished by the friction of the barrel, is constant, it is easy to deduce the following expression for the velocity:—

$$v = Q \times \sqrt{\frac{s}{m}}, \tag{4}$$

in which Q denotes a constant depending on the quantity of powder and diameter of the rifle, s the length of the barrel, and m the weight of the bullet.

Taking the velocity of the belted bullet, 1021·7 feet, as our datum, and calculating the velocities of the others from (4), we find

TABLE VI.—*Theoretical and observed Velocities.*

	Calculated.	Observed.	Difference.
	Ft.	Ft.	Ft.
Minié bullet in 2-grooved rifle,	849·0	847·0	+ 2·0
Sugarloaf, ...	866·8	863·7	+ 3·1
Regulation Minié, ...	915·0	909·08	+ 5·92
Carbine bullet, ...	1083·7	1257·49	−173·79

The agreement of these results is very striking in the case of the rifles, and proves the truth of equation (4); and the disagreement in the case of the carbine proves, as might be expected, that the force of the powder is greater in the smooth bore than in the rifle. From the preceding results, we may assert, with confidence, that the velocity with which a bullet is propelled from a rifle by a given charge of powder depends mainly on the *weight of the bullet* and the *length of the barrel*, varying *inversely* as the square root of the former, and *directly* as the square root of the latter.*

The following experiments were made to ascertain the resistance of the air to bullets of different figures and weights. The bullets were fired at 80 feet distance, from the two-groove rifle into the pendulum, and the velocities calculated from formula (1).

The constants of the pendulum were—

g = 32·195 feet. π = 3·14159.
T = 1·29 sec. c = 77 in.
a = 60 in. Weight of pend. after Exprs. = 51·20 lbs.

TABLE VII.—*Minié Bullet at* 80 *Feet.*

No.	*n.*	*b.*	*f.*	*v.*
		In.	In.	Ft.
1.	501	11·75	72·50	836·42
2.	502	11·87	71·00	864·54
3.	503	11·12	72·00	800·25
4.	504	11·00	69·00	827·68
5.	505	11·25	71·00	824·28
6.	507	11·37	69·00	860·61

Mean velocity = 835·62 feet.
Mean quantity of motion = 83·22 lbs.
Mean quantity of Work = 1080 lbs. lifted one foot.

TABLE VIII.—*Sugarloaf Bullet at* 80 *Feet.*

No.	*n.*	*b.*	*f.*	*v.*
		In.	In.	Ft.
1.	516	11·50	71·00	860·95
2.	517	11·37	71·00	852 87
3.	518	11·25	71·00	845·50
4.	519	10·62	67·75	838·05
5.	520	11·12	69·00	863·27

Mean velocity = 852·13 feet.
Mean quantity of motion = 81·53 lbs.
Mean quantity of Work = 1079 lbs. lifted one foot.

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* The former of these laws was proved by Mr. Hutton to hold for smooth-bore guns of large size, but the latter did not hold true for his experiments. I suppose the reason it is nearer the truth in rifles is on account of the increased friction in the latter.

TABLE IX.—*Belted Bullet at* 80 *Feet.*

No.	*n.*	*b.*	*f.*	*v.*
		In.	In.	Ft.
1.	731	8·62	71·00	912·13
2.	732	8·25	69·00	901·58
3.	734	8·62	69·00	944·59
4.	735	7·62	66·00	874·15
5.	736	7·75	67·00	876·99

Mean velocity = 901·88 feet.
Mean quantity of motion = 62·23 lbs.
Mean quantity of Work = 869·7 lbs. lifted one foot.

Collecting the preceding results into one Table, we obtain—

TABLE X.

	Velocity at Muzzle.	Velocity at 80 Feet.	Quantity of Motion at Muzzle.	Quantity of Motion at 80 Feet.	Quantity of Work at Muzzle.	Quantity of Work at 80 Feet.
	ft.	ft.	lbs.	lbs.	ft. lbs.	ft. lbs.
Minié bullet (two-grooved), ...	847	835·62	84·33	83·22	1109	1080
Minié bullet (regulation), ...	909·08	. . .	96·63	. . .	1364	. . .
Sugarloaf bullet, . . .	863·7	852·13	82·63	81·53	1108	1079
Belted bullet, ...	1021·68	901·88	70·39	62·23	1116	869·7
Carbine bullet, . . .	1257·49	. . .	70·24	. . .	1371	. . .

From this Table it appears—

1st. That the quantity of motion communicated by a given quantity of powder to the Minié bullet, discharged from the regulation rifle, is greater than the quantity of motion possessed by any of the other bullets; this result being due partly to the greater weight of the bullet, and partly to the greater length of the rifle.

2nd. That the quantity of motion communicated to the belted bullet, discharged from the two-grooved or Brunswick rifle, is less than that possessed by the other rifle bullets, this result being due to the lesser weight of the belted bullet.

3rd. That the quantity of motion communicated to the carbine bullet is equal to that possessed by the belted rifle bullet, although the carbine is shorter and its bullet lighter; this result being due to the greater friction of the bullet in the rifled barrel.

4th. That in traversing 80 feet of still air, the quantity of motion of the Minié bullet is diminished by $\frac{1}{76}$th; of the sugarloaf bullet by $\frac{1}{75}$th; and of the belted bullet by $\frac{1}{8\cdot 6}$th,—the remarkable inferiority of the belted bullet being principally due to its shape, which appears to have been contrived so as to cause the maximum amount of resistance to its passage through the air.

5th. That the large stock of Brunswick two-grooved rifles constructed for the use of the British rifle service, might be made as useful as the regulation Minié rifles, by adapting to them a bullet of the proper weight, shaped like the Minié bullet, provided with two projections at the side to fit the grooves of the rifle, and used with or without the iron 'culot' of the French bullets.

The length of barrel of the Brunswick rifle is 30 inches, and the size of bore is 0·704 inch. Calculating from these data the weight of the ball which should be used with this rifle in order to produce the same quantity of motion as in the Minié regulation rifle, I find it to be 967 grs., or $7\frac{1}{4}$ balls to the pound. If Minié balls of this weight were constructed to suit the bore of the Brunswick rifle, and provided with projections or wings to fit the grooves, they would be as efficient as the regulation rifles of 39 inches in length.

6th. That the quantity of Work depends only on the gun and powder; being the same for the Minié bullet, the sugarloaf bullet, and the belted bullet, when fired from the same rifle, with the same charge of powder; and of the guns examined, being greatest for the carbine and Minié regulation rifle.

7th. That in traversing the same distance in air, the two elongated bullets suffered equally in quantity of Work; and much less than the belted bullet, which lost most Work. As the penetrating power of a bullet depends on the quantity of Work it contains, and on its shape, we can see in the last result a reason for the extraordinary and persistent power of penetration, at long ranges, which has been observed to reside in the Minié and conical rifle bullets.

In penetrating 80 ft. of still air:—

The Minié ball lost . . . 29 ft. lbs. of work, or $\frac{1}{38{\cdot}24}$th of initial Work.
The conical ball lost . . . 29 ft. lbs. of work, or $\frac{1}{38{\cdot}21}$th ,,
The belted ball lost . . . 246 ft. lbs. of work, or $\frac{1}{4{\cdot}53}$rd ,,

although the amount of Work residing in the three balls was practically the same at the muzzle of the rifle, and equal to 1111 ft. lbs.

8th. I have found from carefully conducted experiments, that a half-inch cylindrical, flat-headed, steel bolt, will penetrate the best Staffordshire crown plate, $\frac{5}{16}$ inch in thickness, if it be given 720 foot-pounds of Work.

The amount of Work in the rifle bullets just described is much greater than this, which may be taken as a unit of penetrating Work; and there is no reason why these balls should not penetrate iron plates of this thickness, if they were made of steel, instead of lead.

By the courtesy of the Ordnance Select Committee, I am enabled to compare with the preceding results obtained from small arms the more important results obtained, during the last year, from experiments made on heavy ordnance with Navez's electro-ballistic apparatus. I select the following from the velocities obtained with smooth-bore and rifled ordnance.

TABLE XI.—*Smooth-bore and Rifled Ordnance.*

	Nature of Ordnance.	Charge.	Projectile.		Initial Velocity.	Velocity at 90 Feet.
			Nature.	Weight.		
		lbs. ozs.		lbs. ozs.	ft. per sec.	ft. per sec.
I.	68-pr. 95 cwt., . . .	16 0	R. shot,	66 4	1579·0	1553·3
II.	„ „ . . .	„ „	Nav. shot,	51 8	1809·9	1769·4
III.	„ „ . . .	„ „	Com. shot,	49 14	1790·7	1750·3
IV.	12-pr. 18 cwt., . . .	4 0	Sol. shot,	12 10½	1769·8	1718·6
V.	12-pr. Armstrong, . .	1 8	S. shell,	11·75 lb.	1242·8	1233·2
VI.	20-pr. Armstrong, Land service, .	2 8	Shot,	21·20 „	1114·3	1107·2
VII.	20-pr. Armstrong, Sea service, .	2 8	Shot,	21·20 „	997·5	991·4
VIII.	40-pr. Armstrong, Land service, .	5 0	Shot,	41·50 „	1134·1	1128·2
IX.	100-pr. Armstrong, . .	12 0	Shot,	111·6 „	1124·7	1120 0
X.	100-pr. Armstrong, . .	12 0	C. shell,	103·8 „	1166·1	1161·4

From the preceding Table I have calculated the following results:—

TABLE XII.—*Work of Projectiles from Smooth-bore and Rifled Ordnance.*

	Ordnance.	Work at Muzzle.	Work at 90 Feet.	Difference.
I.	68-pr. R. shot, . . .	1145 tons lifted 1 ft.	1108 ft. tons.	37 ft. tons, or $\frac{1}{30\cdot95}$
II.	„ Nav. shot, . .	1170 „ „	1118 „	52 „ $\frac{1}{22\cdot50}$
III.	„ Com. shot, . .	1109 „ „	1060 „	49 „ $\frac{1}{22\cdot63}$
IV.	12-pr. Sol. shot, . .	274·8 „ „	259·8 „	15 „ $\frac{1}{18\cdot32}$
V.	„ Armstrong, S. shell, .	125·8 „ „	123·9 „	1·9 „ $\frac{1}{66\cdot2}$
VI.	20-pr. Armstrong, Land-service shot, .	182·5 „ „	180·2 „	2·3 „ $\frac{1}{79\cdot3}$
VII.	„ Armstrong, Sea-service shot, .	146·2 „ „	144·4 „	1·8 „ $\frac{1}{81\cdot2}$
VIII.	40-pr. Armstrong, Land-service shot, .	370·0 „ „	366·2 „	3·8 „ $\frac{1}{97\cdot4}$
IX.	100-pr. Armstrong shot, .	978·6 „ „	970·4 „	8·2 „ $\frac{1}{119\cdot3}$
X.	„ Armstrong C. shell, .	978·4 „ „	970·6 „	7·8 „ $\frac{1}{125\cdot4}$

APPENDIX A.—*Abstract showing the Mean Initial Velocities of various Service and Experimental Projectiles, determined by Captain Andrew Noble, R. A., under direction of the Ordnance Select Committee, by means of Navez's Electro-Ballistic Apparatus.*

Nature of Ordnance.	No. of Rounds.	Charge.		Projectile.				Velocity at 30 Yards.	Initial Velocity.	REMARKS.
				Nature.	Weight.		Diam.			
		lbs.	oz.		lbs.	oz.	in.	ft.	ft.	
10-in. gun, 87 cwt.	10	12	0	Hol. shot,	88	5	9·84	1270·4	1292·3	Experiments to ascertain the initial velocity of projectiles fired with Service charges from Service guns.
,, ,,	5	8	0	Martin's shell,	117	0	9·84	930·1	940·6	
68-pr., 95 cwt. .	12	16	0	R. shot,	66	4	7·91	1553·3	1579·0	
,, ,, . .	7	16	0	Nav. sh.,	51	8	7·91	1769·4	1809·9	
,, ,, . .	9	16	0	Com. sh.,	49	14	7·91	1750·3	1790·7	
,, ,, . .	5	10	0	Martin's shell,	60	0	7·84	1287·6	1308·5	
8-in. gun, 65 cwt.	5	10	0	Com. sh.	46	0	7·85	1455·0	1487·9	
				Hol. sh.						
,, ,, . .	5	10	0	Com. sh.,	49	14	7·85	1434·6	1464·4	
,, ,, . .	5	10	0	Martin's shell,	51	8	7·92	1475·8	1506·4	
32-pr., 58 cwt. .	10	10	0	Solid shot,	31	6	6·17	1653·7	1690·0	
,, ,, . .	11	8	0	,,	31	6	6·17	1584·7	1618·7	
,, ,, . .	11	6	0	,,	31	6	6·17	1418·8	1447·5	
24-pr., 50 cwt. .	11	8	0	,,	23	8	5·60	1679·5	1720·5	
18-pr., 57 cwt. .	12	6	0	,,	17	11	5·09	1646·8	1690·6	
12-pr., 18 cwt. .	10	4	0	,,	12	10½	4·52	1718·6	1769·8	
9-pr. brass, smooth, 13½ cwt. . . .	4	0	14	*R. shot,*	9	5	4.08	At 25 yds. 1011.2	1101.6	
,, ,, .	3	1	8	,,	9	5	4.08	1310.9	1444.0	
9-pr., 13 cwt., .	10	2	8	Solid shot,	9	5¾	4·10	At 30 yds. 1563·9	1613·7	
6-pr., 6 cwt., . .	10	1	8	,,	6	3¾	3·57	1435·3	1484·5	
12-pr. hr., 6½ cwt.,	10	1	4	Com. sh.,	8	12	4·55	1124·2	1163·4	
24-pr. hr., 12 cwt.,	10	2	8	,,	16	11½	5·595	1218·0	1252·7	
Wall piece, . . .	8	drs. 8		Shot,	0	5¼	0·935	1134·8	1167·6	

Nature of Ordnance.	No. of Rounds.	Charge.	Projectile.			Velocity at 30 Yards.	Initial Velocity.	REMARKS.
			Nature.	Weight.	Diam.			
		drs.		gr.	in.	ft.	ft.	
Enfield rifle, . .	3	2·5	Ser. ball,	530	0·55	1188·7	1272·8	Experiments to ascertain the initial velocity of projectiles fired with Service charges from Service guns.
		lbs. oz.		lbs. oz.				
6-pr. A., 3½ cwt.,	15	0 12	Seg. sh.,	6 0	2·585	937·5	946·4	
12-pr. A., 8½ cwt.,	10	1 8	,,	11 9	3·084	1180·9	1190·2	
12-pr. A., 8½ cwt.,	21	1 8	,,	10 14½	3·084	1187 5	1197·4	Preliminary experiments with 12-pr. Armstrong gun.
,, ,, .	11	1 8	,,	11 13	3·083	1181·5	1190·6	Experiments to ascertain the initial velocity of the 12-pr. Armstrong projectile in function of the weight of the shot.
,, ,, .	5	1 8	,,	11 9	3·083	1195·4	1204·8	
,, ,, .	6	1 8	,,	11 5	3·084	1190·8	1200·4	
,, ,, .	7	1 8	,,	11 1	3·083	1205·6	1215·6	
,, ,, .	11	1 8	,,	11 13	3·084	1164·5	1173·4	
,, ,, .	11	1 8	,,	11 5	3·084	1192·9	1202·5	
,, ,, .	10	1 8	,,	10 13	3·084	1209·8	1220·1	
,, ,, .	10	1 4	,,	11 9	3·084	1055·3	1063·1	Experiments to ascertain the initial velocity of the 12-pr. Armstrong projectile in function of the weight of the charge.
,, ,, .	10	1 6	,,	11 9	3·085	1092·4	1100·7	
,, ,, .	10	1 8	,,	11 9	3·084	1180·9	1190·2	
,, ,, .	10	1 10	,,	11 9	3·084	1224·8	1234·6	
,, ,, .	10	1 12	,,	11 9	3·084	1262·0	1272·2	
,, ,, .	10	0 14	,,	11 9	3·084	803·8	809·2	Experiments to ascertain the initial velocity of the 12-pr. Armstrong projectile in function of the weight of the charge (2nd series).
,, ,, .	10	1 0	,,	11 9	3·084	863·9	870·0	
,, ,, .	10	1 2	,,	11 9	3·084	924·6	931·1	
,, ,, .	10	1 4	,,	11 9	3·084	997·8	1005·1	
,, ,, .	10	1 6	,,	11 9	3·084	1050·2	1058·0	
,, ,, .	10	1 8	,,	11 9	3·084	1106·4	1114·8	
,, ,, .	10	1 10	,,	11 9	3·084	1178·0	1187·3	
,, ,, .	5	1 8	,,	11 9	3·080	1184·1	1193·4	Low gauge; bore washed. Experiments to ascertain the difference between the initial velocities of high and low gauge 12-pr. Armstrong projectiles, and also the effect of lubricating wads.
,, ,, .	6	1 8	,,	11 9	3·085	1177·2	1186·5	High gauge do.
,, ,, .	11	1 8	,,	11 9	3·080	1184·1	1193·4	Low gauge; lubricating wads.
,, ,, .	8	1 8	,,	11 9	3·085	1187·8	1197·1	High gauge; do.
,, ,, .	15	1 8	,,	11 9	3·072	1154·2	1163·2	G. pattern shell; lubricat^{g} wads. Experiments to ascertain the difference between the initial velocities of old and new pattern 12-pr. A. shells, with or without lubricat'g wads.
,, ,, .	14	1 8	,,	11 9	3·085	1157·1	1166·1	Service shell; do.
,, ,, .	13	1 8	,,	11 9	3·085	1142·0	1150·8	Do. bore washed.
,, ,, .	10	1 8	,,	11 9	3·072	1140·6	1149·4	G. pattern shell no wads.

Nature of Ordnance.	No. of Rounds.	Charge.		Projectile.				Velocity at 30 Yards.	Initial Velocity.	REMARKS.
				Nature.	Weight.		Diam.			
		lbs.	oz.		lbs.	oz.	in.	ft.	ft.	
12-pr. A., 8½ cwt.,	7	1	2	Seg. sh.	9	0	3·074	1130·0	1141·2	Experiments to ascertain the initial velocity of a 9 lb. shell fired with a charge of 1 lb. 2 oz. from a 12-pr. gun.
,, ,, .	5	1	8	,,	9	0	3·074	1322·2	1336·3	Experiments to ascertain the initial velocity of projectiles fired from a 12-pr. Armstrong gun in function of the weight of the projectile.
,, ,, .	6	1	8	,,	11	9	3·084	1227·4	1237·2	
,, ,, .	6	1	8	,,	24	6	3·084	853·9	856·7	
,, ,, .	6	1	8	,,	35	14	3·084	720·0	721·5	
,, ,, .	5	1	8	,,	47	13	3·084	613·9	614·8	
32-pr. rifled shunt gun, 59 cwt. .	4	5	8	Pl. shells,	54·0		6·35	1215·7	1224·5	Experiments to ascertain the initial velocity of a projectile fired from a rifled, and of one of the same weight and form fired from a smooth-bored gun.
,, ,, .	3	5	8	,,	54·0		6·35	1122·1	1136·3	
32-pr., 59 cwt., smooth, . .	8	5	8	,,	54·0		6·35	1187·4	1201·7	
32-pr. rifled shunt gun, . . .	4	5	8		54·0		6·35	1054·6	1061·7	Cartridge, 12 in. long. Experiments to ascertain the initial velocities of projectiles fired from a 32-pr. rifled shunt gun, with charges made up in cartridges of various lengths.
,, .	3	5	8		54·0		6·35	1076·8	1084·2	,, 9 ,,
,, .	1	5	8		54·0		6·35	1102·2	1109·8	,, 8 ,,
,, .	1	5	8		54·0		6·35	1114·5	1122·3	,, 7½ ,,
,, .	2	5	8		54·0		6·35	1187·9	1196·4	,, 6 ,,
12-pr. A., 6 cwt.,	8	1	6		11	9	3·074	1103·4	1111·8	Experiments to ascertain the initial velocity of a 12-pr. Armstrong shell fired from a 12-pr. gun of 6 cwt.
12-pr. A., 8½ cwt.,	4	1	8		11	9	3·074	1238·3	1248·2*	Experiments to ascertain the effect of diminishing the lead on the base of the 12-pr. Armstrong projectile.
,, ,, .	2	1	8		11	9	3·010	1200·2	1209·7†	
,, ,, .	2	1	8		11	9	3·010	1163·7	1172·8‡	
,, ,, .	2	1	8		11	9	3·010	1089·6	1097·9§	

* Shell fired under normal circumstances.

† Same shell, lead reduced to the same diameter as the gun with the exception of a ring 0·25 inch broad at the base of the original dimensions.

‡ Shell reduced throughout to the diameter of the bore of the gun.

§ Same as last, but a different description of powder employed.

(Signed) ANDREW NOBLE.

Appendix B.—*Abstract showing the Results of Experiments with Armstrong Guns, carried on at Shoeburyness, with Navez's Electro-Ballistic Apparatus, by Lieut. W. H. Noble, R. A., under the direction of the Ordnance Select Committee; September and October*, 1861.

Nature of Gun.	No. of Gun.	Calibre in Inches.	Length of Bore in Calibres.	No. of Rounds.	Charge.		Projectile.			Velocity at 30 Yards from Muzzle.	Initial Velocity.	REMARKS.
							Nature.	Weight.	Diameter.			
					lbs.	oz.		lbs.	inches.			
12-pr., ...	8	3·00	24·5	28	1	8	S. shell,	11·75	3·074	1233·2	1242·8	Three rounds, fired with every gun for comparison.
20-pr., Land Service, .	40	3·75	22·4	5	2	8	Shot,	21·2	3·836	1107·2	1114·3	
20-pr., Land Service, shortened 6 in., .	27	3·75	20·8	6	2	8	,,	21·2	3·836	1098·4	1105·4	6 in. were blown off the muzzle of this gun at practice.
20-pr., Sea Service, .	13	3·75	14·4	5	2	8	,,	21·2	3·836	991·4	997·5	
40-pr., Land Service, .	35	4·75	22·4	5	5	0	,,	41·5	4·836	1158·2	1164·4	
40-pr., shortened, . .	136	4·75	17·6	5	5	0	,,	41·5	4·836	1128·2	1134·1	
100-pr. howitzer, . .	—	7·00	10·6	6	9	0	C. shell,	103·8	7·088	949·4	953·4	
100-pr., ...	91	7·00	14·2	6	12	0	Shot,	111·6	7·088	1120·0	1124·7	
,, .	91	7·00	—	6	12	0	C. shell,	103·8	7·088	1161·4	1166·1	
												Powder. $\frac{\text{L.G.R.}}{\text{A4}}$ 29 5 61 Lot 333. KO,NO_5, . . 75·35 S, . . 10·28 C, . . 13·82 Moisture, . . 0·35 100·0

All the Guns were fired with Service charges and the Service wad. The first rounds were neglected in taking a mean, as the velocity was found to be much greater after the gun had been lubricated.

WILLIAM H. NOBLE, Lieut. R. A.

Woolwich, October 23, 1861.

The ballots for the annual election of President, Council, and Officers, having been scrutinized in the face of the Academy, the President reported that the following gentlemen were duly elected:—

President.—The Very Rev. Dean Graves, D. D.

Council.—Rev. George Salmon, D. D.; Rev. Samuel Haughton, M. A.; Rev. J. H. Jellett, M. A.; Robt. W. Smith, M. D.; Rev. H. Lloyd, D.D.; William K. Sullivan, M. D.; and Robert M'Donnell, M. D.: on the Committee of Science.

Rev. Samuel Butcher, D.D.; Rev. Joseph Carson, D. D.; John F. Waller, LL.D.; John Kells Ingram, LL. D.; Digby P. Starkey, Esq.; John Anster, LL. D.; and the Right Hon. Joseph Napier, LL. D.: on the Committee of Polite Literature.

John T. Gilbert, Esq.; Rev. William Reeves, D. D.; Eugene Curry, Esq.; William R. Wilde, Esq.; George Petrie, LL. D.; W. H. Hardinge, Esq.; and the Right Hon. Lord Talbot de Malahide: on the Committee of Antiquities.

Treasurer.—Rev. Joseph Carson, D.D.

Secretary of the Academy.—Rev. William Reeves, D. D.

Secretary of the Council.—John Kells Ingram, LL. D.

Secretary of Foreign Correspondence.—Rev. Samuel Butcher, D. D.

Librarian.—John T. Gilbert, Esq.

Clerk, Assistant Librarian, and Curator of the Museum.—Edward Clibborn, Esq.

MONDAY, APRIL 14, 1862.

The Very Rev. Charles Graves, D. D., President, in the Chair.

Andrew Armstrong, Esq.; John Campbell, Esq., M. B.; John Stratford Kirwan, Esq.; and George Porte, Esq., C. E.; were elected members of the Academy.

Mr. J. T. Gilbert, on the part of R. R. Madden, Esq., read the following paper:—

On certain Cromlechs in Northern Africa.

(Plate XVI.)

In the month of December, 1861, while sojourning in Algiers, the existence in that colony of some ancient Pagan monuments of supposed Druidical origin was brought to my knowledge by a brief notice of them in the "Revue Africaine," for Nov., 1861 (No. 30, p. 38)—an archæological journal of considerable merit, published in Algiers, under the direction of the President of the "Societé Historique Algerienne," Monsieur Berbrugger, an eminent antiquarian and oriental scholar. Referring to the